Lummi Nation Water Reclamation and Reuse

September 1998

LUMMI NATION WATER RECLAMATION AND REUSE

Prepared For:
Lummi Indian Business Council

Funded By:
Bureau of Reclamation
(Cooperative Agreement No. 1425-5-FC-10-01480)

Prepared By:
Jeremy Freimund, Water Resources Manager

Reviewers:

Leroy Deardorff	Lummi Environmental Director
Harriet Beale	Lummi Water Resources Manager (former)
Gene Decoteau	Lummi Sewer District Manager
Victor Solomon	Lummi Water Field Superintendent
Linda Delgado	Lummi Salmon Enhancement Manager
Bill Finkbonner	Skookum Creek Hatchery Manager
Andy Ross	Lummi Water Resources Specialist
Shandra Fitzpatrick	Lummi Water Resources Planner
Harry Johnsen	Raas, Johnsen, & Stuen, P.S.
Jane Marx, Jana Walker	Williams & Janov, P.C.

September 1998

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Water reclamation and reuse opportunities on the Lummi Reservation (Reservation) and at the Lummi Nation (Lummi or Lummi Nation) owned and operated Skookum Creek Fish Hatchery were evaluated. The evaluation consisted of: a review of current regulations and standards for reclaiming and reusing wastewater, an inventory and characterization of potential sources of wastewater, identification of the costs associated with water reclamation and reuse, and an assessment of wastewater reuse opportunities for each source.

In general, current water reclamation and reuse opportunities on the Reservation are limited by the costs to 1) monitor the reclaimed water quality, 2) provide additional treatment to the available wastewater, 3) convey the reclaimed water to places of reuse, and 4) the relatively low cost of potable water. At some time in the future, especially with new economic development activities, water reclamation and reuse may become more cost effective.

The evaluation of Lummi water reclamation and reuse opportunities is divided into the following six Sections:

- Section 1 is an introductory section.
- Section 2 describes current regulations for reclaimed water and identifies the treatment and quality requirements for common uses of reclaimed water.
- Section 3 identifies the potential sources of reclaimed water for the Lummi Nation and describes the quality of the wastewater from each source in terms of the water reclamation standards.
- Section 4 identifies the costs associated with reclaiming wastewater.
- Section 5 summarizes the evaluation results and presents conclusions regarding Lummi water reclamation and reuse opportunities.
- Section 6 lists all references used in the study.

1. INTRODUCTION

The purpose of this study is to evaluate water reclamation and reuse opportunities on the Lummi Reservation (Reservation) and at the Lummi Nation (Lummi or Lummi Nation) owned and operated Skookum Creek Fish Hatchery. The evaluation is comprised of:

- a review of current regulations and standards for reclaimed water;
- an inventory and characterization of potential sources of wastewater;
- identification of the costs associated with water reclamation and reuse; and
- an assessment of wastewater reuse opportunities for each source.

Lummi water reclamation and reuse opportunities are being evaluated for a number of reasons including:

- ground and surface water resources are limited and in some cases insufficient for the current needs of the Lummi Nation;
- economic development, institutional development, and population growth on the Reservation are projected to increase demands for the limited water supply;
- if water can be reclaimed and reused, diversions of river water can be reduced and more water made available to support needed instream flows and other uses;
- if water can be reclaimed and reused, fish production in the hatcheries and other uses can be expanded; and
- reclaiming and reusing water is consistent with a long-term vision of integrated and conjunctive water management.

Water reclamation is a process where wastewater from one use is adequately and reliably treated so that it is suitable for another use. Reclaiming water is a way to conserve the potable water supply by using non-potable water for applications that do not require potable water (e.g., irrigation, flushing sanitary sewers, dust control). The conserved potable water can be used to help meet current and future water needs of the Lummi Nation.

Water reuse can be either direct or indirect (Viessman and Hammer 1985). Direct water reuse involves treating wastewater and piping the effluent directly into some type of water system without intervening travel dilution in natural surface or ground water bodies. For example, piping wastewater effluent from a wastewater treatment plant to an irrigated field is a direct use. Indirect water reuse involves an intermediate step between the generation of reclaimed water and reuse. The intermediate step commonly includes discharge, retention, and mixing with another water supply prior to reuse. An example of an indirect use is an intake for a water supply system downstream from the outfall from a wastewater treatment plant. Wastewater from the treatment plant enters, mixes with, and becomes part of a natural surface water resource prior to being reused. Local examples of indirect reuse include the Lummi operated Seaponds and Mamoya Ponds salmon propagation facilities (hatcheries) and the Whatcom County Public Utility District (PUD) No. 1 intake along the Nooksack River. Wastewater treatment plants, urban and rural areas, and agricultural lands discharge wastewater to the river upstream from the intakes for these facilities.

Untreated wastewater is commonly reused within fish hatcheries and in irrigated agriculture. In a single pass through, gravity-fed fish hatchery, water supplied to raceways can be serially reused to supply rearing ponds located down gradient. In such reuse applications, the number of fish in the rearing ponds is reduced to compensate for the presence of metabolic wastes in the supplied water (Bertolini 1997). In agriculture, inefficient irrigation and drainage practices result in excess applied water which is often collected in ditches and used again, without treatment, to irrigate other fields or to provide instream flows.

Although objectives such as preventing environmental degradation, avoiding public nuisance, and meeting user requirements are critical to a successful water reuse program, the most important objective in any water reuse program is protecting public health (EPA 1992). Protecting public health is achieved by (EPA 1992):

- reducing concentrations of pathogenic bacteria, parasites, and enteric viruses in the reclaimed water;
- controlling chemical constituents in reclaimed water; and/or
- limiting public exposure (e.g., contact, inhalation, ingestion) to the reclaimed water.

To protect public health, a water reclamation and reuse system must (EPA 1992):

- ensure that the residual pollutants are reliably removed to the extent necessary to make the water acceptable for the designated reuse; and
- ensure that adequate setback distances are provided to preclude both mixing of reclaimed water with potable water, and inadvertent public contact with reclaimed water.

This evaluation of Lummi water reclamation and reuse opportunities is organized into the following six Sections:

- Section 1 is this introduction section.
- Section 2 describes current regulations for reclaimed water and identifies the treatment and quality requirements for common uses of reclaimed water.
- Section 3 identifies the potential sources of reclaimed water for the Lummi Nation and describes the quality of the wastewater from each source in terms of the water reclamation standards.
- Section 4 identifies the costs associated with reclaiming wastewater.
- Section 5 summarizes the evaluation results and presents conclusions regarding Lummi water reclamation and reuse opportunities.
- Section 6 lists all references used in the study.

2. WATER RECLAMATION AND REUSE REGULATIONS

The U.S. Environmental Protection Agency (EPA) has developed guidelines for treatment processes, reclaimed water quality limits, monitoring frequencies, setback distances, and other controls for various water reuse applications (EPA 1992). These guidelines are intended to promote the development of water reclamation and reuse programs or appropriate regulations. Although the EPA developed water reclamation and reuse guidelines, there are no federal reclamation and reuse standards. The responsibility for developing water reclamation and reuse standards was left to state and tribal governments. To date, the Lummi Nation has not developed water reclamation and reuse standards. This evaluation is the first step in assessing the potential for such a program, and may eventually lead to the development of tribal water reclamation and reuse standards for the Reservation.

Washington State recently used a "Blue Ribbon" advisory committee and the primary author of the 1992 EPA *Guidelines for Water Reuse* to develop water reclamation and reuse standards. The Washington State standards were developed jointly by the Washington Department of Health and Department of Ecology (DOH and DOE 1997) and are based on the best standards of Arizona, California, and Florida where water reclamation and reuse systems and regulations are relatively well developed (DOH 1996a). The standards focus on basic treatment levels and reliability requirements and are intended to ensure that treatment is both adequate and reliable for the planned reuse.

Because the goals of the Washington State standards are consistent with goals of the Lummi Nation regarding public health protection, and because the Washington State standards are based on EPA guidelines, if the Lummi Nation adopted water reclamation and reuse standards, they could be expected to be similar to the Washington State standards. Consequently, in the absence of Lummi Nation and federal water reclamation and reuse standards, the Washington State standards were used as the basis to evaluate potential wastewater reclamation and reuse opportunities on the Reservation.

In this Section of the report, the Washington State reclaimed water treatment standards, reclaimed water quality requirements for specific uses, reclaimed water monitoring requirements, and use area requirements are summarized. In addition to the standards and requirements identified below, an engineering report is required before reclaimed water can be produced or supplied. The report must be prepared by a registered engineer experienced in the field of wastewater treatment and must contain a description of the proposed reclamation system design and how the system operation will ensure compliance with the water reclamation and reuse standards (DOH and DOE 1997).

2.1 RECLAIMED WATER TREATMENT STANDARDS

The treatment standards for reclaimed water in Washington State are separated into four levels identified by the letters A, B, C, and D. Class A reclaimed waters have the highest water quality standards and correspondingly the highest number of possible uses. Class D reclaimed waters have the lowest water quality standards and the lowest number of possible uses.

All four classes of reclaimed water require that the wastewater be disinfected and oxidized. Disinfected wastewater is wastewater in which pathogenic organisms have been destroyed by chemical, physical, or biological means (DOH and DOE 1997). Disinfection practices for reclaimed water are measured in terms of total coliform rather than in terms of fecal coliform as has been traditionally used to measure the effectiveness of wastewater disinfection. Oxidized wastewater is defined as wastewater in which (DOH and DOE 1997):

- organic matter has been stabilized to the extent that the biochemical oxygen demand (BOD) does not exceed 30 milligrams per liter (mg/l);
- total suspended solids (TSS) do not exceed 30 mg/l;
- the wastewater is nonputrescible; and
- the wastewater contains dissolved oxygen (DO).

The four classes of reclaimed water are defined in Table 2.1. Although the definitions in Table 2.1 for Class A and Class B reclaimed water may appear similar, the difference between the two classes is that Class B reclaimed water does not require coagulation or filtration. The coagulation step involves the addition of pre-treatment chemicals (e.g., Alum or polymers) that are similar to the chemicals used to treat drinking water. The coagulation step increases the effectiveness of filtration and provides a pathogen barrier for viruses and cysts (e.g., giardia). The filtration process further reduces any pathogens and, along with coagulation and disinfection, is generally designed to achieve a 99.9 percent inactivation of the most resistant disease causing organisms (DOH 1996a).

As shown in Table 2.1, Class B reclaimed water requires a ten-fold reduction in total coliform relative to Class C reclaimed water. Similarly, the Class C reclaimed water standards require a ten-fold reduction in total coliform relative to Class D reclaimed wastewater.

Table 2.1 Reclaimed water treatment standards

Reclaimed Water Class	Definition[1]
A	Reclaimed water that, at a minimum, is at all times an oxidized, coagulated, filtered, disinfected wastewater. The wastewater shall be considered to be adequately disinfected if: • The median number of total coliform colonies in the wastewater after disinfection does not exceed 2.2 per 100 milliliters (as determined from the bacteriological results of the last seven days for which analyzes have been completed). • The number of total coliform colonies does not exceed 23 per 100 milliliters in any sample.
B	Reclaimed water that, at a minimum, is at all times an oxidized and disinfected wastewater. The wastewater shall be considered to be adequately disinfected if: • The median number of total coliform colonies in the wastewater after disinfection does not exceed 2.2 per 100 milliliters (as determined from the bacteriological results of the last seven days for which analyzes have been completed) • The number of total coliform colonies does not exceed 23 per 100 milliliters in any sample.
C	Reclaimed water that, at a minimum, is at all times an oxidized and disinfected wastewater. The wastewater shall be considered to be adequately disinfected if: • The median number of total coliform colonies in the wastewater after disinfection does not exceed 23 per 100 milliliters (as determined from the bacteriological results of the last seven days for which analyzes have been completed). • The number of total coliform colonies does not exceed 240 per 100 milliliters in any sample.
D	Reclaimed water that, at a minimum, is at all times an oxidized and disinfected wastewater. The wastewater shall be considered to be adequately disinfected if: • The median number of total coliform colonies in the wastewater after disinfection does not exceed 240 per 100 milliliters (as determined from the bacteriological results of the last seven days for which analyzes have been completed).

[1] DOH and DOE 1997

2.2 RECLAIMED WATER QUALITY REQUIREMENTS FOR SPECIFIC USES

Where human exposure in a water reuse application is likely, a high degree of treatment should be achieved prior to its use (EPA 1992). Conversely, where public access to a water reuse site can be restricted so that exposure is not likely, a lower level of treatment may be satisfactory as long as worker safety is not compromised.

The Washington State treatment and quality requirements for common reclaimed water uses are summarized in Table 2.2. As shown in Table 2.2, Class A reclaimed water is suitable for most unrestricted uses except for consumption and ground water injection. The quality requirements for ground water injection have not been finalized in Washington State. In other states however, high levels of treatment and restrictive reclaimed water quality standards, including conformance to drinking water quality standards, are required for ground water injection (HDR 1996).

As shown in Table 2.2, the Class A reclaimed water standards must be reliably met before wastewater can be used for irrigation of open access areas such as golf courses, parks, playgrounds, school yards, and residential landscapes. Class B reclaimed water is suitable for areas not accessible to the general public; it can be used in areas where there are controls and worker/employee knowledge that reclaimed water is being used (DOH 1996a). The treatment standard for reuse in fish hatcheries is Class B. In general, moderate levels of irrigation restrictions apply to Class C reclaimed water; the water is also suitable for commercial uses such as dust control. Class D reclaimed water use is limited to irrigation on restricted access seed and fiber crops; it may be suitable for drip irrigation in less restricted access areas (DOH 1996a). Class D reclaimed water is suitable for irrigation of hybrid poplar plantations.

Table 2.2 Treatment and quality requirements for reclaimed water use (DOH and DOE 1997)

Use	Type of Reclaimed Water Allowed			
	Class A	Class B	Class C	Class D
1. Irrigation of Nonfood Crops				
Trees and fodder, fiber, and seed crops	Yes	Yes	Yes	Yes
Sod, ornamental plants for commercial use, and pasture to which milking cows or goats have access	Yes	Yes	Yes	No
2. Irrigation of Food Crops				
Spray Irrigation				
All food crops	Yes	No	No	No
Food crops which undergo physical or chemical processing sufficient to destroy all pathogenic agents	Yes	Yes	Yes	Yes
Surface Irrigation				
Food crops where there is no reclaimed water contact with edible portion of crop	Yes	Yes	No	No
Root crops	Yes	No	No	No
Orchards and vineyards	Yes	Yes	Yes	Yes
Food crops which undergo physical or chemical processing sufficient to destroy all pathogenic agents	Yes	Yes	Yes	Yes
3. Landscape Irrigation				
Restricted access areas (e.g., cemeteries and freeway landscapes)	Yes	Yes	Yes	No
Open access areas (e.g., golf courses, parks, playgrounds, schoolyards, and residential landscapes)	Yes	No	No	No
4. Impoundments				
Landscape impoundments	Yes	Yes	Yes	No
Restricted recreational impoundments	Yes	Yes	No	No
Nonrestricted recreational impoundments	Yes	No	No	No
5. Fish Hatchery Basins	Yes	Yes	No	No
6. Decorative Fountains	Yes	No	No	No
7. Flushing of Sanitary Sewers	Yes	Yes	Yes	Yes
8. Street Cleaning				
Street sweeping, brush dampening	Yes	Yes	Yes	No
Street washing, spray	Yes	No	No	No
9. Washing of Corporation Yards, Lots, and	Yes	Yes	No	No

Table 2.2 Treatment and quality requirements for reclaimed water use (DOH and DOE 1997)

Use	Type of Reclaimed Water Allowed			
	Class A	Class B	Class C	Class D
Sidewalks				
10. Dust Control (Dampening Unpaved Roads, and Other Surfaces)	Yes	Yes	Yes	No
11. Dampening of Soil for Compaction (e.g., at construction sites, landfills, etc.)	Yes	Yes	Yes	No
12. Water Jetting for Consolidation of Backfill Around Pipelines				
Pipelines for reclaimed water, sewage, storm drainage, gas, and conduits for electricity	Yes	Yes	Yes	No
13. Fire Fighting and Protection				
Dumping from aircraft	Yes	Yes	Yes	No
Hydrants or sprinkler systems in buildings	Yes	No	No	No
14. Toilet and Urinal Flushing	Yes	No	No	No
15. Ship Ballast	Yes	Yes	Yes	No
16. Washing Aggregate and Making Concrete	Yes	Yes	Yes	No
17. Industrial Boiler Feed	Yes	Yes	Yes	No
18. Industrial Cooling				
Aerosols or other mist not created	Yes	Yes	Yes	No
Aerosols or other mist created (e.g., use in cooling towers, forced air evaporation, or spraying)	Yes	No	No	No
19. Industrial Process				
Without exposure of workers	Yes	Yes	Yes	No
With exposure of workers	Yes	No	No	No
20. Ground Water Recharge				
Direct recharge (injection)	No	No	No	No
21. Wetlands[1]				
Discharge to constructed beneficial use wetlands	Yes	Yes	No	No
Discharge to natural wetlands	Yes	Yes	Yes	Yes
Human non-contact restricted access	Yes	Yes	Yes	No
Fisheries or human non-contact recreation	Yes	Yes	No	No
Human contact	Yes	No	No	No

[1] Additional requirements for discharges to wetlands are addressed in Section 2.3 of this report.

2.3 RECLAIMED WATER MONITORING REQUIREMENTS

As noted previously, the water reclamation and reuse standards developed by Washington State are based on basic treatment levels and reliability requirements. To ensure that reclaimed water reliably meets the standards defined for a particular treatment class and use, sampling and analysis requirements were established. The general monitoring requirements for reclaimed water in Washington State are summarized in Table 2.3. All analyses must be performed using approved laboratory methods conducted at certified laboratories.

Table 2.3 Reclaimed water monitoring requirements (DOH and DOE 1997)

Parameter	Sample Type and Frequency	Compliance Requirements
1. Biochemical Oxygen Demand (BOD)	24-hour composite, collected at least weekly	Shall not exceed 30 mg/l determined monthly, based on the arithmetic mean of all samples collected during the month
2. Total Suspended Solids (TSS)	24-hour composite, collected at least daily	Shall not exceed 30 mg/l determined monthly, based on the arithmetic mean of all samples collected during the month
3. Total Coliforms	Grab, collected at least daily	Compliance determined daily, based on the median value determined from the bacteriological results of the last 7 days for which analyses have been completed.
4. Turbidity	Continuous recording turbidimeter	Filtered wastewater shall not exceed an average operating turbidity of 2 NTU, determined monthly, and not exceed 5 NTU at any time.
5. Dissolved Oxygen	Grab, collected at least daily	Shall contain dissolved oxygen

As summarized below, additional background studies and monitoring are required for discharging reclaimed water to wetlands. Prior to discharging reclaimed water to wetlands, sufficient background studies must be performed to (DOH and DOE 1997):

- identify the category of the existing wetland (i.e., Category I, Category II, Category III, or Category IV wetland) and proposed wetland;
- identify the existing beneficial uses of the existing and proposed wetland;
- determine the hydrologic regime of the existing and proposed wetland, including depth and duration of inundation, average monthly water level fluctuation, and an estimated monthly water budget with comparisons to actual conditions during operation;
- identify class of reclaimed water to be discharged, associated parameter concentrations, and annual loading rates to the wetlands;
- determine whether the wetland occurs in a ground water recharge or discharge area;

- provide baseline monitoring information for natural wetlands sufficient to allow determination of reference conditions for physical, chemical, and biological parameters to be performed during a growing season prior to initiation of discharge;
- provide an estimated description of the mature biological structure for a constructed beneficial use wetland; and
- support any claims of net environmental benefit.

In addition to these background studies, the monitoring and compliance requirements for reclaimed water discharged to wetlands in Washington State are shown in Table 2.4.

Table 2.4 Monitoring requirements for wetland applications (DOH and DOE 1997)

Parameter	Sample Type and Frequency	Compliance Requirements
1. Biochemical Oxygen Demand (BOD)	24-hour composite, collected at least weekly	Shall not exceed 20 mg/l on an average annual basis
2. Total Suspended Solids (TSS)	24-hour composite, collected at least daily	Shall not exceed 20 mg/l on an average annual basis
3. Total Coliforms	Grab, collected at least daily	Compliance determined daily, based on the median value determined from the bacteriological results of the last 7 days for which analyses have been completed.
4. Kjeldahl Nitrogen	24-hour composite collected weekly	Shall not exceed 3 mg TKN-N/l on an average annual basis
5. Total Ammonia-Nitrogen	24-hour composite collected weekly	Shall not exceed chronic standards for freshwater
6. Total Phosphorus	24-hour composite collected weekly	Shall not exceed 1 mg P/l on an average annual basis
7. Metals: Arsenic, Cadmium, Copper, Lead, Mercury, Nickel, Zinc	24-hour composite collected weekly	Shall not exceed surface water standards
8. Flow Rate	Continuous Recording	2 to 5 cm/day, depending on wetland category and type
9. Water Level Elevation	Continuous Recording	Increase not greater than 10 cm above average pre-augmentation water level elevation
10. Biological: Vegetation cover, plant diversity, macro-invertebrate biomass,	Once per year during first, second, fourth, sixth, eighth, and tenth growing season	No more than 25 percent reduction in parameter measurements over wetland, or 50 percent reduction in any one

Table 2.4 Monitoring requirements for wetland applications (DOH and DOE 1997)

Parameter	Sample Type and Frequency	Compliance Requirements
amphibian species, fish biomass and species, bird density and species, threatened/ endangered density and species		location within wetland.

2.4 RECLAIMED WATER USE AREA REQUIREMENTS

Procedures and regulations intended to prevent cross connections and improper or inadvertent use of reclaimed water as potable water are necessary for public health protection (EPA 1992). Preventing cross connections means to avert a physical connection between a potable water system used to supply water for drinking purposes and any source containing nonpotable water which could contaminate the potable water.

Preventing cross connections can be accomplished by requiring setback distances between potable and nonpotable water lines. For Washington State, the maximum attainable separation distance between reclaimed and potable water lines must be used. A minimum horizontal separation of 10 feet and a minimum vertical separation of 18 inches is required between reclaimed and potable water lines. Also, potable water lines must be located above reclaimed water lines. Other setback distances for various conditions and classes of reclaimed water for Washington State are summarized in Table 2.5.

In addition to setback distances, measures to prevent improper or inadvertent use of reclaimed water as potable water include (EPA 1992):

- clearly and consistently identifying all components (e.g., pipes, pumps, outlets, valve boxes) of the nonpotable system through color coding and marking;
- preventing the onsite ability to tie into a reclaimed water line by requiring specialized tools;
- installing backflow prevention devices on potable water lines to prevent any nonpotable water from moving through the water distribution system;
- employing safeguards when converting existing potable water lines to nonpotable uses; and
- posting signs and implementing public education campaigns to notify the public and employees at all reclaimed water use areas.

Table 2.5 Setback distances by type of reclaimed water (DOH and DOE 1997)

Conditions	Setback Distance by Type of Reclaimed Water (feet)			
	Class A	Class B	Class C	Class D
1. Minimum distance between any reclaimed water pipeline and potable water supply well.	50	100	100	300
2. Where reclaimed water is used for spray or surface irrigation, minimum distance between the area subject to irrigation and any potable water supply well.	50	100	100	300
3. Where reclaimed water is used for spray irrigation, minimum distance between the area subject to irrigation and areas accessible to the public and the use area property line.	0	50	50	100
4. Where reclaimed water is used for an impoundment that is not lined or sealed to prevent measurable seepage, minimum distance between the perimeter of the impoundment and any potable water supply well.	500	500	500	N/A
5. Where reclaimed water is used for an impoundment that is lined or sealed to prevent measurable seepage, minimum distance between the perimeter of the impoundment and any potable water supply well.	100	100	100	N/A
6. Where reclaimed water is used for a storage pond that is not lined or sealed to prevent measurable seepage, minimum distance between the perimeter of the pond and any potable water supply well.	500	500	500	1,000
7. Where reclaimed water is used for a storage pond that is lined or sealed to prevent measurable seepage, minimum distance between the perimeter of the pond and any potable water supply well.	100	100	100	200

3. POTENTIAL WATER RECLAMATION AND REUSE SOURCES

The feasibility of water reclamation and reuse on the Reservation and at the Skookum Creek Fish Hatchery is dependent on a number of factors including:

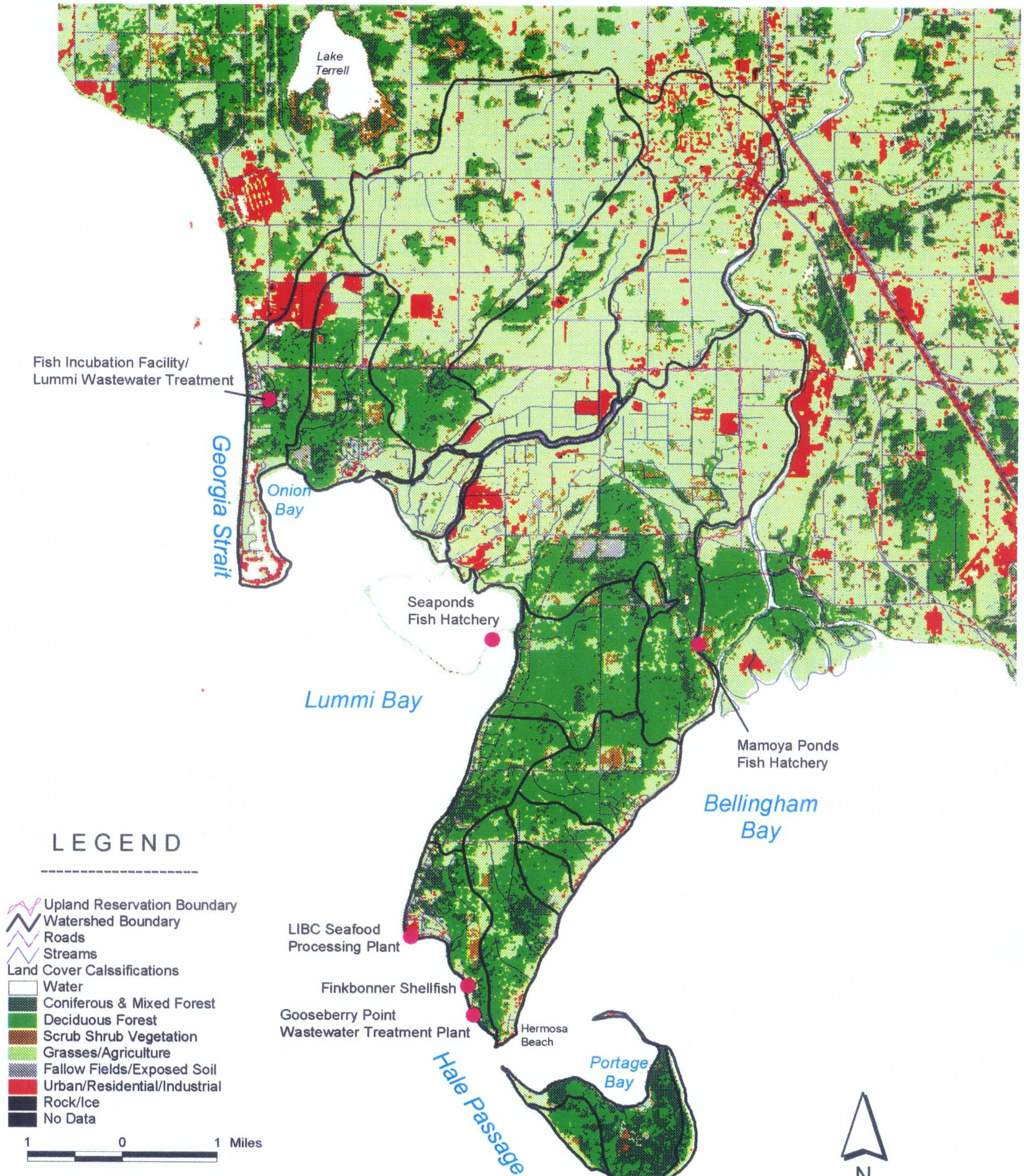
- the quantity, timing, and quality of the available wastewater;
- the potential uses of the reclaimed water and the location of these potential uses;
- the cost to provide appropriate monitoring, adequate treatment, and conveyance of the reclaimed water; and
- the cost of potable water.

In this Section of the report, the quantity, timing, quality, and potential uses of the available wastewater are described. In Section 4, the monitoring, treatment, and conveyance costs are presented along with the current costs for potable water.

3.1 WASTEWATER QUANTITY

All facilities on the Reservation and the single off-Reservation facility operated by the LIBC which discharge or are capable of discharging wastewater to the “waters of the United States” were initially considered as potential wastewater sources for reclamation and reuse. As listed in Table 3.1, the potential wastewater sources are two wastewater treatment plants, four salmon propagation facilities (fish hatcheries), and two seafood processing plants. A third seafood processing plant on the Reservation (Native American Shellfish Company) discharges wastewater to the Gooseberry Point Wastewater Treatment Plant and was not considered a potential source of wastewater for reclamation and reuse. The receiving water body, the estimated average wastewater flow during the months of maximum and minimum discharges, and the estimated average annual wastewater volume from each potential source are also shown in Table 3.1.

Except for the Skookum Creek Fish Hatchery, all of the potential sources of effluent for water reclamation and reuse are located within the exterior boundaries of the Reservation. The locations of the facilities on the Reservation, as well as adjacent land uses, are shown in Figure 3.1. As shown in Figure 3.1, all of the potential sources of reclaimed water on the Reservation are adjacent to either residential or forestry land uses. The Skookum Creek Fish Hatchery is located along a rural reach of the South Fork Nooksack River approximately 40 miles from the Reservation and is not shown in Figure 3.1.



Source: LANDSAT IV Thematic Mapper
Sub-Scene acquired @9:30am on August 15, 1991.
Obtained from Whatcom County, WA Planning Office.

Figure 3.1 Locations of Potential Wastewater Sources and Reservation Land Uses.

Table 3.1 Potential sources of reclaimed water for the Lummi Nation

Facility	Receiving Water Body	Average Flow During Month of Maximum Wastewater Flow (mgd)	Average Flow During Month of Minimum Wastewater Flow (mgd)	Average Annual Wastewater Volume (gallons [gal] and acre-feet [ac-ft])
1. Gooseberry Point Wastewater Treatment Plant[1]	Hale Passage	0.289	0.160	85,962,371 gal 263.8 ac-ft
2. Sandy Point Wastewater Treatment Plant[1]	Georgia Strait	0.200	0.101	54,348,338 gal 166.8 ac-ft
3. Sandy Point Fish Hatchery	Georgia Strait	0.123	0.048	29, 276,874 gal 89.9 ac-ft
4. Skookum Creek Fish Hatchery	South Fork Nooksack River	7.801	0.508	1,532,014,043 gal 4,701.9 ac-ft
5. Seaponds Fish Hatchery[2]	Lummi Bay	0.737	0.000	30,430,631 gal 93.4 ac-ft
6. Mamoya Ponds Fish Hatchery[2]	Kwina Slough	3.071	0.000	126,740,985 gal 389.0 ac-ft
7. Lummi Indian Business Council Seafood Processing Plant[3]	Hale Passage	0.030	0.000	3,662,146 gal 11.2 ac-ft
8. Finkbonner Shellfish Company[3]	Hale Passage	0.0001	0.0001	40,174 gal 0.1 ac-ft

[1] Flow estimated from Discharge Monitoring Reports submitted monthly to the EPA over the October 1992 through September 1996 period.
[2] September through May, current water supply shortages prevent fresh water use from June through Aug.
[3] Wastewater flow rates do not include seawater circulated through live crab tanks.

The average annual total volume of wastewater currently available from the eight facilities listed in Table 3.1 is approximately 5,715 acre-feet. As illustrated in Figure 3.2, the four fish hatcheries combined are the largest potential sources of reclaimed water for the Lummi Nation. The average annual volume of effluent from the hatcheries is about 5,275 acre-feet or about 94 percent of the total amount of wastewater generated. The Skookum Creek Fish Hatchery generates over 70 percent of the total wastewater from the hatcheries. Because of its remote location however, the Skookum Creek Fish Hatchery is not considered a source of reclaimed water for use on the Reservation. The average annual total volume of wastewater currently available for reclamation and reuse on the Reservation is approximately 1,015 acre-feet. This volume is expected to increase in the coming years as the population on the Reservation increases, economic development activities occur, and institutions expand or develop (e.g., Northwest Indian College, Tribal school, new jail, etc.).

After the fish hatcheries, the largest potential sources of reclaimed water for the Lummi Nation are the two wastewater treatment plants. The combined average annual wastewater volume from the plants is currently about 520.5 acre-feet or about six percent of the total amount of wastewater. The seafood processing plants produce less than one percent of the total amount of wastewater.

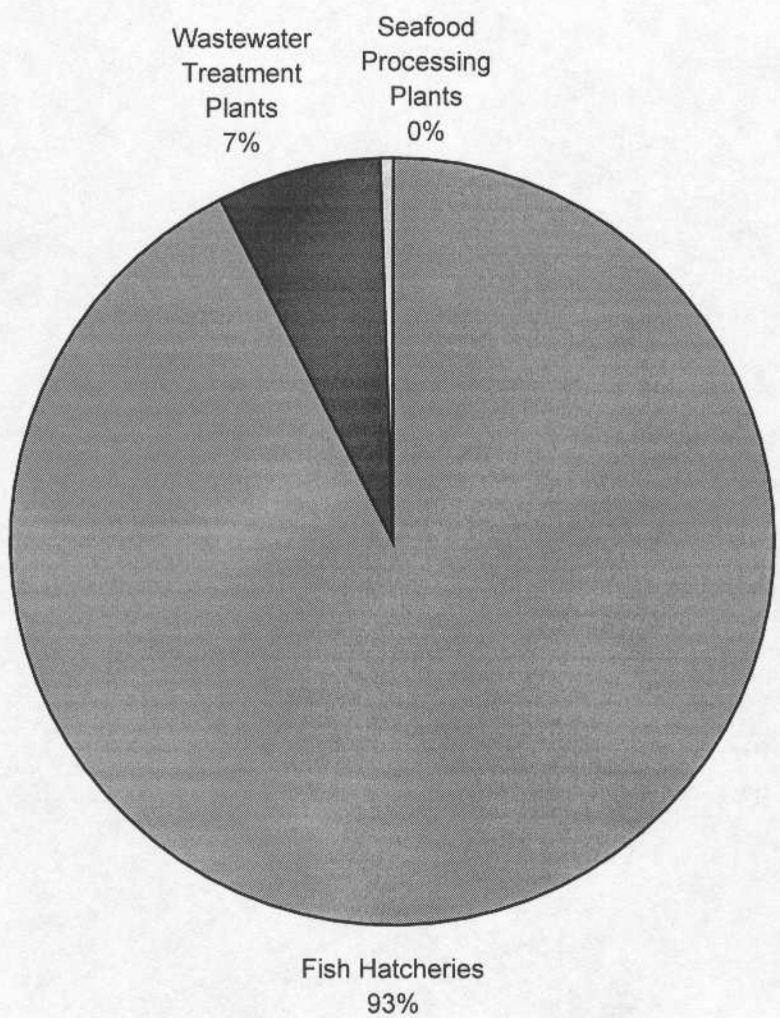


Figure 3.2 Annual Quantity of Wastewater by Source

3.2 WASTEWATER AVAILABILITY

As shown in Figure 3.3, wastewater availability changes during the year for the different sources and is always greatest at the Skookum Creek Fish Hatchery. Figure 3.4 shows the wastewater availability for the on-Reservation sources only. As shown in Table 3.1 and Figure 3.4, only the two wastewater treatment plants and the Sandy Point Fish Hatchery provide on-Reservation wastewater in significant quantities throughout the year.

The estimated average monthly quantities of wastewater available from the two wastewater treatment plants and the Sandy Point Fish Hatchery during the May through October irrigation season are shown in Table 3.2.

Table 3.2 Estimated average monthly wastewater volume during the irrigation season

Month	**Estimated Average Monthly Wastewater Volume (acre-feet)**		
	Gooseberry Point Wastewater Treatment Plant	**Sandy Point Wastewater Treatment Plant**	**Sandy Point Fish Hatchery**
May	22.0	14.9	5.5
June	22.8	10.8	4.4
July	15.2	19.0	4.7
August	27.5	10.0	8.1
September	20.8	12.2	8.3
October	18.1	10.9	8.7

An acre-foot is a unit of water volume and is equal to the amount of water necessary to cover an acre of land to a depth of one foot. As an example, during the month of August, reclaimed wastewater from the Sandy Point Fish Hatchery could be used to cover 24 acres of grassland to a depth of 4 inches.

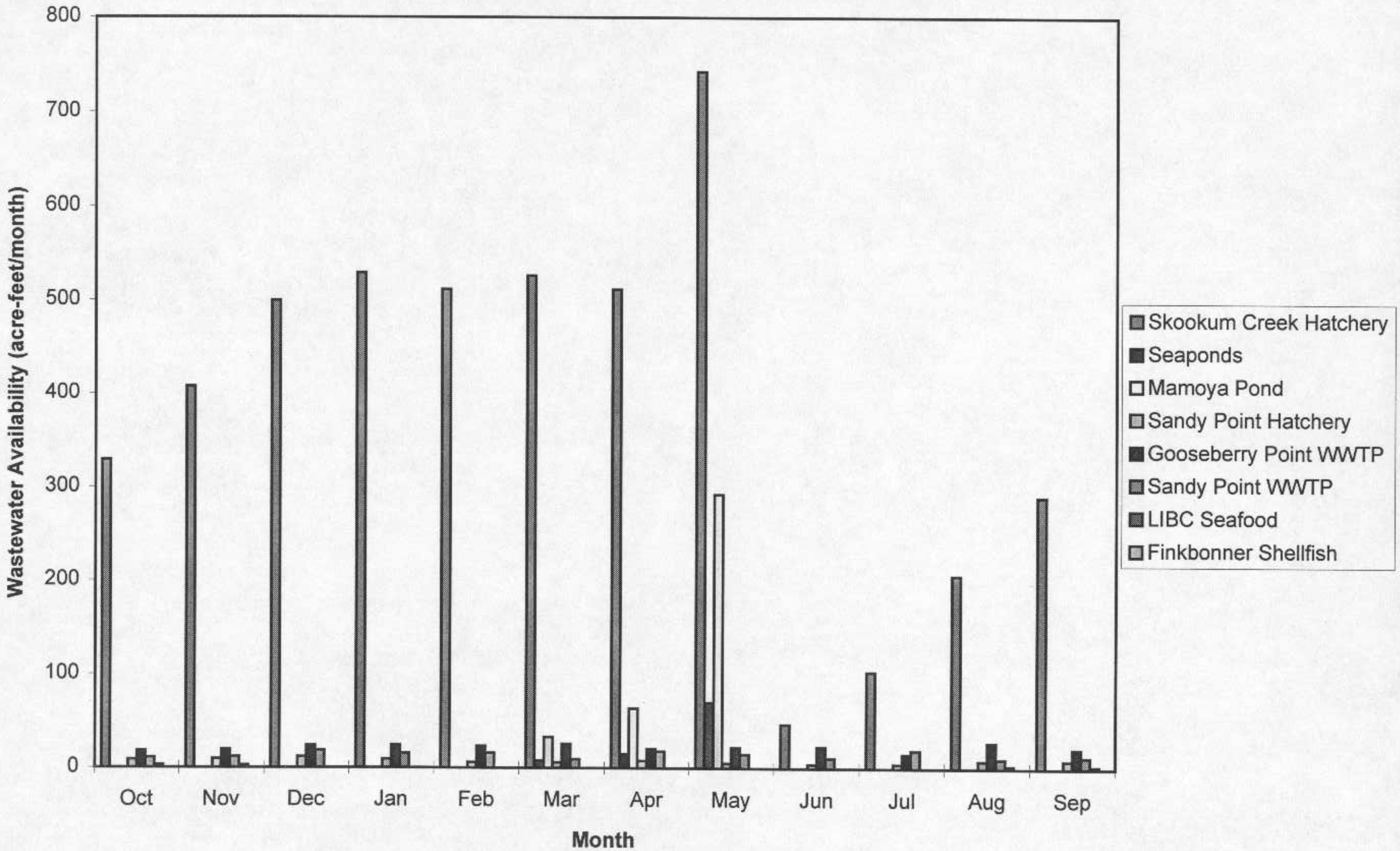


Figure 3.3 Timing and Quantity of Wastewater Availability

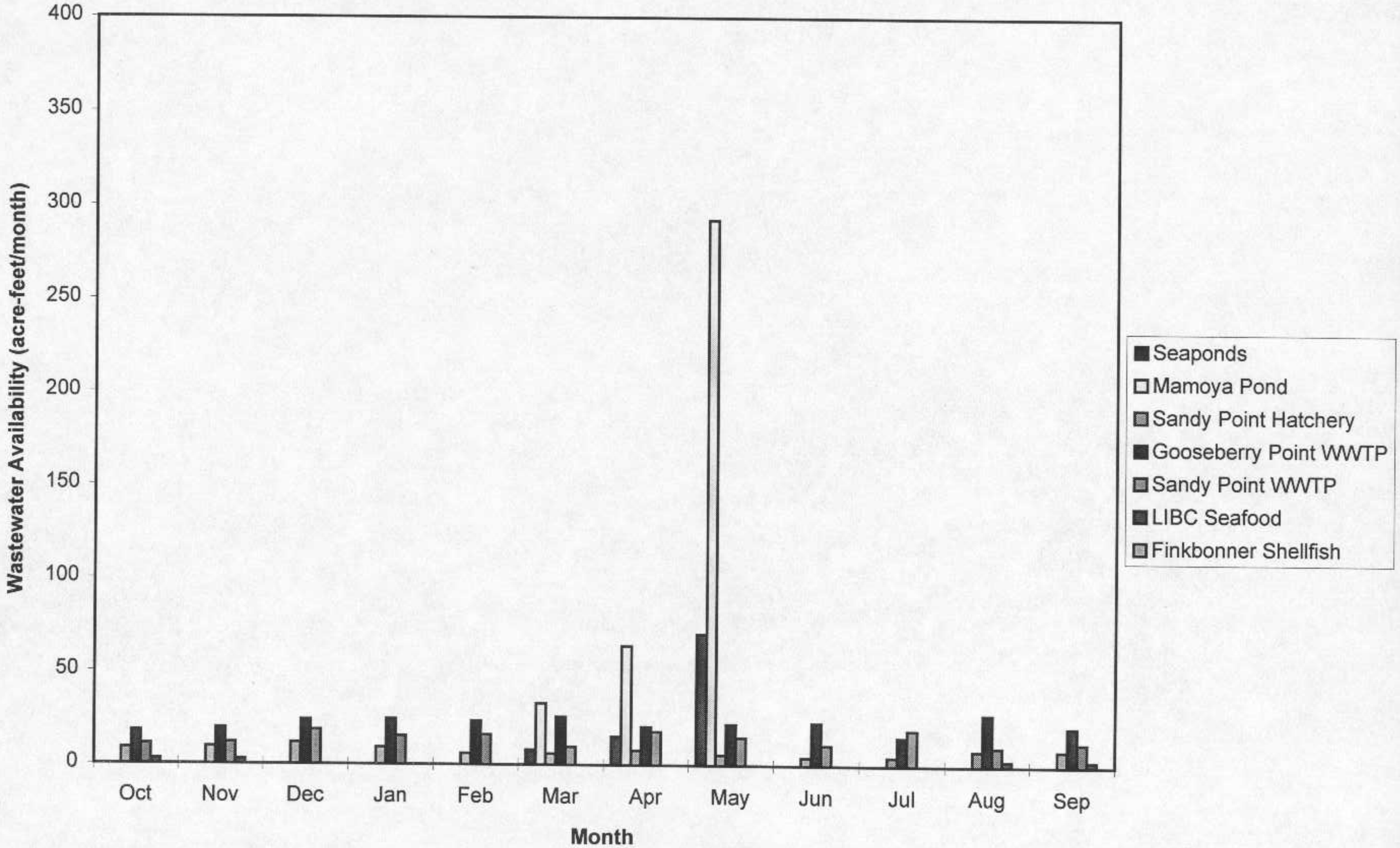


Figure 3.4 Timing and Quantity of Wastewater Availability on the Lummi Reservation

3.3 WASTEWATER QUALITY

Because of environmental and public health protection concerns, the possible uses of reclaimed water are limited by the quality of the treated wastewater. As described in Section 2 of this report, reclaimed water can be divided into four classes (A, B, C, and D) based on the level of treatment. At a minimum, all reclaimed water must be disinfected and have:

- biochemical oxygen demand (BOD) less than 30 mg/l;
- total suspended solids (TSS) less than 30 mg/l;
- be nonputrescible; and
- contain dissolved oxygen (DO).

Currently, data on the amount of BOD, TSS, and DO in the wastewater are routinely collected for only two of the eight possible sources of effluent for reclamation and reuse. These data, along with data on the amount of fecal coliform bacteria, pH, chlorine residual, and flow are collected and reported in compliance with the National Pollutant Discharge Elimination System (NPDES) permits issued to the Gooseberry Point and Sandy Point wastewater treatment plants (WWTPs). Fish hatchery NPDES permits only require the monitoring of TSS and settleable solids. The BOD, total coliforms, turbidity, and DO are not monitored for the fish hatcheries. As part of this evaluation, the Sandy Point Fish Hatchery effluent was sampled and analyzed for BOD, TSS, total coliform, DO, ammonia as nitrogen, Total Kjeldahl Nitrogen, potassium, and phosphorus.

In addition to the development of an engineering report, before any of the potential sources of water for reclamation could be used, an expanded sampling and analysis program would have to be established to ensure that the reclaimed water reliably meets all of the quality standards for the planned reuse.

3.3.1 Wastewater Treatment Plants

The Gooseberry Point and Sandy Point wastewater treatment plants have similar designs; both provide secondary treatment. Sewage treatment at each plant is provided by headworks with bar screen and comminutor, two primary clarifiers, an aeration basin, two rotating biological contactor (RBC) units, two secondary clarifiers, and a dual chlorine contact basin. Disinfection of the effluent is provided using chlorine.

The quantity and quality of the effluent from the two wastewater treatment plants was estimated from the Discharge Monitoring Reports (DMRs) submitted by the two treatment plants as part of their NPDES permit compliance. Only the DMRs over the October 1992 through September 1996 (i.e., four water years) were used in the analysis because these data are likely to be more representative of future conditions than samples collected when fewer homes were connected to the sewer systems. The average monthly BOD, TSS, fecal coliform, pH, dissolved oxygen, chlorine residual, and flow for the Gooseberry Point and Sandy Point WWTPs are reported each month.

The Lummi Nation is working with the Portland Area Indian Health Service (IHS) and EPA Region 10 to upgrade its wastewater treatment plants through a technical assistance program co-sponsored by the IHS and EPA. The Lummi Sewer District is also listed in the IHS Sanitation Deficiency System for a nearly 1.3 million dollar system upgrade.

The NPDES sampling parameters and frequency are different than the monitoring required for reclamation. For example, the sampling frequency for TSS in the NPDES permit is weekly rather than the daily sampling frequency required for water reclamation. Similarly, the coliform sampling frequency for NPDES compliance is weekly rather than daily as required for water reclamation. In addition, only fecal coliform (as opposed to total coliform) testing is required for the NPDES permit. Also, since the NPDES permit requires reporting on the average number of fecal coliform colonies in the wastewater after disinfection rather than the median number of total coliform, the data in the DMRs could not be used to directly determine if the median number of fecal coliform exceed the maximum 240 per 100 milliliters threshold for Class D reclaimed water. The turbidity of the effluent is not a monitored parameter at the two treatment plants.

Until the on-going technical assistance program, the planned treatment plant upgrades, and additional monitoring ensure that effluent from the two wastewater treatment plants reliably meet the water quality standards for Class D reclaimed water, and until an engineering report is developed, the effluent from these sources cannot be reused. Additionally, prior to reuse the current effluent quality monitoring program needs to be modified so that all of the required parameters are monitored (e.g., turbidity, total coliform) and some of the monitored parameters are monitored more frequently (e.g., total coliform, TSS).

3.3.2 Seafood Processing Plants

Although water quality data for the effluent from the seafood processing plants is limited, the federal water quality guidelines for BOD and TSS for effluent from seafood processing plants suggest that additional treatment will be required before the effluent from these sources can be reclaimed and reused.

According to NPDES permit applications, the largest seafood processing plant on the Reservation can use a maximum of 30,000 gallons per day (gpd) of water for finfish processing. This level of water use could occur at the Lummi Indian Business Council (LIBC) Seafood Processing Plant during 180 days of the year.

To estimate the quality of the wastewater from the seafood processing plants, it was assumed that the wastewater quality complies with federal regulations for the west coast mechanized salmon processing subcategory for a new source (40 CFR, Subpart S, 408.195). For this subcategory, the average daily effluent limitations for BOD5 over a 30-day period is 38 pounds per 1,000 pounds of seafood. The average daily effluent limitation for total suspended solids is 7.6 pounds per 1,000 pounds of seafood.

These federal effluent limitations were converted to units of mg/l to allow comparison with the reclamation and reuse standards. To convert the units, the average quantity of water necessary to process one pound of salmon was estimated from the EPA development documents (EPA 1975). The average flow rate from the two northwest processing plants reviewed in the EPA development documents was calculated to be 0.435 gallons per pound (gal/lb) of seafood.

Using the 0.435 gal/lb water requirement, and the average daily BOD effluent limitation of 38 lbs of BOD per 1,000 lbs of seafood, it was calculated that the federal guidelines allow approximately 0.0874 lbs of BOD per gallon of wastewater. This quantity converts to about 10,472 mg/l of BOD in the effluent. Using the same approach, it was determined that there could be up to 0.0175 lbs of total suspended solids (TSS) per gallon of wastewater or approximately 2,093 mg/l.

From these data, it is clear that the allowable levels of BOD and TSS in the wastewater from seafood processing plants greatly exceed the 30 mg/l concentration required for an oxidized wastewater. To achieve the water quality standards for Class D reclaimed water, treatment and monitoring beyond what is federally required for wastewater from seafood processing plants must also be provided.

Although connecting the seafood processing plants to the Gooseberry Wastewater Treatment Plant could provide treatment and produce Class D reclaimed water, the wastewater treatment plant currently does not have the capacity to treat the high concentrations of BOD and TSS that the seafood processing plants generate (Leffel 1997). To treat these wastes to the Class D standards, either the treatment plant capacity would have to be increased at a cost of over a million dollars, or a self-contained treatment plant that provides biological treatment would have to be installed in the processing plants at a cost of about a million dollars.

3.3.3 Fish Hatcheries

There are two basic types of water reuse systems employed at fish hatcheries: water recirculation and serial reuse. In water recirculation systems, water passes through the hatchery or part of the hatchery and then is pumped from an outlet back to an inlet. In serial reuse systems, water is first used for one part of the hatchery (e.g., the raceways) and then reused in another (e.g., rearing ponds) before being discharged at the hatchery outlet.

Recirculating systems are most feasible for egg incubation (Bertolini 1997). Such systems are feasible both because the surfaces of the eggs can be disinfected easily, and because there is little metabolic waste produced as no food is introduced. However, since eggs require frequent chemical treatments for fungus control, a separate water supply is required for the treatment periods. In addition, because water recirculation systems rely on pumps, there is an increased risk of an emergency interruption in water flow. Although this system can be effective, in general the opportunities for water savings at a hatchery are small due to the relatively small volumes of water used for egg incubation.

Serial reuse of water already occurs at some of the Lummi hatcheries. For example, water in the raceways of the Skookum Creek Fish Hatchery is reused to supply the rearing ponds. An additional reuse opportunity at this hatchery may be to use water from the rearing ponds to supply the pond used to hold brood stock during the spawning periods. Currently, a gate is used to supply water diverted from Skookum Creek directly to the brood pond. The materials, labor, and equipment required to reuse water in this manner at the Skookum Creek Fish hatchery was estimated by a local contractor to be about $10,000 (Delgado 1998).

Concerns about disease transmission limit the water reuse opportunities within the four fish hatcheries operated by the Lummi Nation. In general, reusing water at hatcheries increases the potential for pathogenic viruses, bacteria, fungi, and parasites in fish (Bertolini, 1997). Fish exposed to water with high levels of nitrogenous waste products are more susceptible to infection. In addition, the waste products can cause toxicity, certain non-infectious diseases, and poor growth.

The proposed reuse of wastewater from the rearing ponds to supply the brood pond during a low flow period in Skookum Creek (the primary water supply source for the hatchery) would allow more cool, oxygen-laden water to circulate through the rearing ponds (rather than a portion of the diverted water flowing directly to the brood pond) and minimize the need to use aerators. This reuse, however, risks encouraging the vertical transmission (i.e., passing disease agents from parent to progeny) of certain bacterial pathogens (Bertolini 1997). The sub-yearling coho in the rearing ponds usually have some level of the agent that causes bacterial kidney disease (*Renibacterium salmoninarum*) and the agent that causes coldwater disease (*Flexibacter psychrophilus*). The agent that causes bacterial kidney disease is known to be vertically transmitted and there is some evidence that the agent for coldwater disease may also be vertically transmitted (Bertolini 1997).

Although the potential for disease transmission among fish limits the opportunities to reuse wastewater at the hatcheries, there may be opportunities to directly reuse the hatchery wastewater for irrigation or other non-hatchery related uses. If the untreated hatchery wastewater reliably meets the Class D water reclamation standards, additional treatment would not be required to protect public health and the water could be used to irrigate hybrid poplar plantations or for other suitable applications.

As mentioned previously, the wastewater quality sampling programs at the hatcheries do not monitor all five of the parameters required to evaluate reclamation and reuse (BOD, TSS, total coliforms, turbidity, and DO) at the sampling frequency identified in Table 2.2. Like the other potential sources, the opportunities to reclaim and reuse wastewater from the hatcheries are currently limited by the lack of monitoring data that demonstrates that the designated reclaimed quality standard is reliably achieved.

To get a snap shot of the level of treatment that might be required before the effluent from the fish hatcheries could be reused, a single grab sample was collected from the Sandy Point Fish Hatchery wastewater. The effluent from this hatchery was selected for sampling because the hatchery is operated most of the year and because it is located near potential places of irrigation. The single grab sample was collected on May 13, 1997. At the time of sample collection, the fish were sized at about 800 fish per pound in the rearing tanks at the hatchery; the egg incubation facility was not in operation. The results of the sampling and analysis effort are shown in Table 3.5. A longer term and more rigorous sampling and analysis program is required to determine water quality variations over time. These data, along with the engineering report, are required to accurately assess the feasibility of wastewater reclamation and reuse from the Sandy Point Fish Hatchery.

Table 3.5 Effluent water quality for the Sandy Point Fish Hatchery[1]

Water Quality Parameter	May 13, 1997 Sample Results	Complies With Reclaimed Water Standard			
		Class A[2]	Class B	Class C	Class D
Biochemical Oxygen Demand (mg/l)	2.6	No	Yes	Yes	Yes
Total Suspended Solids (mg/l)	< 2.5	No	Yes	Yes	Yes
Dissolved Oxygen (mg/l)	9.1 @ 10.7 C	No	Yes	Yes	Yes
Total Coliform (colonies/100 ml)	80	No	No	No	Yes
Ammonia as Nitrogen	< 0.028	N/A	N/A	N/A	N/A
Total Kjeldahl Nitrogen	0.57	N/A	N/A	N/A	N/A
Potassium	8.75	N/A	N/A	N/A	N/A
Phosphorus	< 0.50	N/A	N/A	N/A	N/A

[1] Based on single grab sample collected on May 13, 1997.
[2] Class A reclaimed water standard requires coagulation and filtration.

As evident from the data shown in Table 3.5, the effluent from the Sandy Point Fish Hatchery at the time of sampling met the water quality standards for Class D reclaimed water. As was shown in Table 2.2, Class D reclaimed water can be reused for flushing sanitary sewers, for irrigating nonfood crops (e.g., trees and fodder, fiber, and seed crops), for spray or surface irrigation of food crops which undergo physical or chemical processing sufficient to destroy all pathogenic organisms, and for surface irrigation of orchards, vineyards, and hybrid poplar plantations.

Disinfection to reduce the number of total coliforms is required to attain the Class B standard necessary for reuse in fish hatchery basins. Because chlorine is toxic to fish, disinfection of the wastewater would have to be accomplished using a process such as ozonation rather than chlorination if the water were to be reused in the hatchery. The water quality requirement for reuse in open access areas such as golf courses, parks, playgrounds, school yards, and residential landscapes is Class A (which requires coagulation and filtration).

The Seaponds and Mamoya Pond fish hatcheries were evaluated as improbable wastewater sources for reclamation and reuse. These two hatcheries are located in remote locations, rely on untreated Nooksack River water of relatively poor quality, and have limited operations due to low instream flows in the Nooksack River during the summer months.

As noted previously, the hatchery diversions are an example of indirect water reuse. The water supply intakes for these facilities are located along Kwina Slough (a distributary channel of the Nooksack River). The water quality of the Nooksack River just upstream from the hatchery intakes varies throughout the year. As shown in Table 3.6, on average the water quality in the Nooksack River at the Washington State Department of Ecology water quality monitoring station at Brennan (Slater Road bridge) did not reliably meet the Class D standard over the November 1993 through December 1997 sampling period. It is noted that samples were collected monthly rather than at the monitoring intervals required for reclaimed water and that not all of the needed parameters were analyzed.

Table 3.6 Summary of water quality along the Nooksack River at Brennan[1]

Water Quality Parameter	**Average Sample Results**	**Number of Samples**	**Complies With Reclaimed Water Standard**			
			Class A[2]	**Class B**	**Class C**	**Class D**
Biochemical Oxygen Demand (mg/l)	NM[3]	NM	No	Yes	Yes	Yes
Total Suspended Solids (mg/l)	91	47	No	No	No	No
Total Coliform (colonies/100 ml)	116	46	No	No	No	Maybe
Turbidity (NTU)	50	47	No	No	No	No
Dissolved Oxygen (mg/l)	11	48	Yes	Yes	Yes	Yes

[1] The Brennan sample station is located along the Nooksack River at Slater Road approximately 2.4 river miles upstream from the Seaponds Fish Hatchery intake and approximately 3.5 river miles upstream from the Mamoya Ponds Fish Hatchery intake. Samples collected monthly over the Nov. 1993 through Dec. 1997 period.
[2] Class A reclaimed water standard requires coagulation and filtration.
[3] Not measured

The unreliable water supply from Kwina Slough has limited the use of the Seaponds and Mamoya Ponds hatcheries to the September through May period. Because low instream flows have limited hatchery operations during the summer months, wastewater is not currently available to reclaim and reuse for irrigation. An improved intake in the lower river, improved water quality, and/or improved flows in the river could change these constraints in the future.

4. ESTIMATED WATER RECLAMATION AND REUSE COSTS

The three general types of costs associated with water reclamation and reuse are monitoring costs, treatment costs, and conveyance costs. Whereas the monitoring costs are about the same for each source, the costs to treat and convey reclaimed wastewater from each source varies. The costs to treat and convey reclaimed wastewater depends on the level of desired treatment as well as the distance and topography that separates the wastewater source and the place of use.

In general, the poor wastewater quality and the resultant high treatment costs, the seasonal timing of water availability, and the remote locations of the two fish processing plants and two of the three on-Reservation fish hatcheries make these sources poor candidates for water reclamation and reuse. The remote locations and the treatment levels required for wastewater before it can be reused also limit the potential uses of reclaimed water from the two wastewater treatment plants and the Sandy Point Fish Hatchery.

Despite their limitations, the two wastewater treatment plants and the Sandy Point Fish Hatchery are currently the primary candidates for water reclamation and reuse on the Reservation. These three wastewater sources are the only on-Reservation sources that have wastewater available during the summer irrigation season. Although these three sources have wastewater available for reclamation and reuse, they are remote from the primary agricultural areas on the Reservation (i.e., the flood plains of the Lummi and Nooksack rivers) and are located near sea level. Because of the topography on the Reservation, reclaimed water would likely have to be pumped to the reuse location(s). The pumping costs are variable and depend on the volume to be pumped and the total elevation the reclaimed water would have to be lifted. In addition, land may have to be purchased or leased for locating reclaimed water pump stations; operating and maintenance costs would also have to be provided. In general, the cost to lay new pipelines to distribute the reclaimed water would be about $22.00 per lineal foot.

As the reuse locations and the locations where the conveyance pipelines and necessary pumps would be placed are unknown, the costs to convey reclaimed water to potential places of reuse could not be determined at this time. The costs to convey reclaimed water to reuse locations should be determined on a case-by-case basis during the planning phase for specific projects and/or in the development of the engineering report.

4.1 MONITORING COSTS

As was discussed previously and summarized in Table 2.3, the monitoring standards for reclaimed water require the use of composite sampling equipment, daily sampling of several parameters, and sample analysis at a certified laboratory. The cost of the sampling equipment is estimated to be about $4,000 (Decoteau 1997). The approximate costs to have the samples analyzed for BOD, TSS, total coliforms, and dissolved oxygen at a certified laboratory are shown in Table 4.1 (Ernst 1997). Turbidity must be recorded continuously by calibrated sampling equipment and would not have to be determined in a laboratory. As the BOD needs to be tested weekly, and the other three parameters tested daily, the approximate weekly costs to analyze the required samples in a certified laboratory is $375.00 per wastewater source. This weekly cost amounts to about $19,500 per year per source. Additional costs would be associated with staff training, sample collection, transportation, and record keeping.

Table 4.1. Unit costs for laboratory analysis of reclaimed water

Test Parameter	EPA Method	Unit Costs ($)[1]
Biochemical Oxygen Demand (BOD)	405.1	38.00
Total Suspended Solids (TSS)	SM2540-D	13.50
Total Coliform/Fecal	SM9221C	25.00
Dissolved Oxygen (DO)	SM4500-O-B	9.50

[1] Ernst 1997

In summary, the sampling equipment (~ $4,000) and the required sample analyses at a certified laboratory (~ $19,500) would cost around $25,000 per source during the first year of monitoring. Additional labor costs would be associated with obtaining, operating, and maintaining the sampling equipment. Consequently, the total cost to adequately characterize the wastewater quality of a single potential source for one year would be about $30,000. Monitoring costs during subsequent years would not include the sampling equipment costs and would be approximately $25,000.

4.2 TREATMENT COSTS

The treatment costs for reclaiming wastewater at the on-Reservation sources were estimated for the wastewater treatment plants, the seafood processing plants, and the Sandy Point Fish Hatchery. Treatment costs for the three other fish hatcheries were not determined because the sources are not considered to be viable sources for on-Reservation water reclamation and reuse due to the poor quality of the water source, location, and/or unavailable wastewater during the summer irrigation season. As the Gooseberry Point and Sandy Point wastewater treatment plants have a similar design, the additional treatment costs are essentially the same at each plant.

4.2.1 Wastewater Treatment Plants

An Indian Health Service (IHS) Utility Consultant for the Seattle District Office identified enhancements at the two wastewater treatment plants that would be necessary to achieve Class A, B, C, and D reclaimed water (Pringle 1997). With improved operation, no additional treatment is required to attain the Class D water quality standards at either the Gooseberry Point or Sandy Point WWTPs.

Modifications to the disinfection system at the WWTPs would be required to achieve the Class C standard (which requires a ten-fold reduction in total coliforms relative to the Class D criteria). Among the probable modifications would be increased chlorine dosages as well as improved mixing of the chlorine with the effluent. The disinfection process used, and/or whether dechlorination is required, will depend on the intended uses of the reclaimed water.

Dechlorination will also require continuous monitoring of the effluent chlorine level. The necessary modifications, including engineering design and construction, could be made at either plant for approximately $300,000 (Pringle 1997).

Even though the Class B criteria does not include a filtration requirement, the level of disinfection required is probably achievable only with the addition of some kind of filtration process. The design process would indicate whether coagulation would also be required. For the Gooseberry Point and Sandy Point treatment plants, some kind of pre-built package granular media filter installed in place would most likely be selected. With filtration would come the added need for continuous monitoring of both chlorine and turbidity. Treatment to the Class B criteria would probably cost around $750,000 at either plant (Pringle 1997).

Class A reclaimed water requires coagulation with the filtration and would cost approximately $1,000,000 at either plant. At this point, consideration should be given to replacing either plant (or both) with an updated plant designed for this level of treatment (Pringle 1997).

4.2.2 Seafood Processing Plants

As mentioned previously, treatment and monitoring beyond what is federally required for wastewater from seafood processing plants would be necessary to achieve the Class D reclaimed water quality standards. Essentially a new wastewater treatment plant that provides biological treatment would be necessary to achieve the targeted treatment levels for Class D reclaimed water. The design, environmental permitting, and construction costs to provide treatment to the Class D standards at the seafood processing plants were estimated to be approximately $1,200,000 (Esvelt 1997).

Clearly some cost savings could be achieved if both of the processing plants used the same treatment plant, or if the Gooseberry Point wastewater treatment plant was upgraded and had the capacity to treat wastewater from the plants.

4.2.3 Sandy Point Fish Hatchery

Available data (one grab sample) suggests that wastewater from the Sandy Point Fish Hatchery might meet the Class D reclaimed water standard without further treatment. Considerably more sampling and analysis is required to determine if the Class D standard is reliably attained and to comply with monitoring requirements. Additional disinfection will be required to achieve the Class A, B, and C standards.

Treatment to the Class B standard is required if the wastewater is to be recirculated through the hatchery. The capital costs to provide an ozonation treatment system to attain Class B standards and to recirculate the wastewater through the hatchery is estimated to be about $18,000 (Dunphy 1997). The capital costs to provide a treatment system that will attain the Class A standards are estimated to be about $55,000 (Dunphy 1997).

4.3 CURRENT COSTS OF POTABLE WATER

The Lummi Water District currently charges residential customers a base fee of $16.65 per month for potable water, which includes 600 ft^3 (4,488 gallons). Every additional 100 ft^3 (748 gallons) of water used during the month costs $1.40. If one acre-foot (325,851 gallons) of potable water were used during a month, it would cost approximately $618. Each additional acre-foot of potable water used during a month would cost about $610.

As noted previously, there are three wastewater sources on the Reservation that generate wastewater during the irrigation season. Although additional monitoring would be required, it is possible that all three of these sources could attain the Class D treatment standard without additional treatment costs. Assuming no additional treatment costs, the costs to reuse Class D reclaimed water for irrigating either an orchard or a hybrid poplar plantation would be the increased monitoring cost, the conveyance cost (e.g., pumps and pipes), and the costs of the engineering report and any additional training. As stated previously, the monitoring costs per source would be approximately $19,500 per year (not including training, sample collection, transportation, and record keeping). The $19,500 annual monitoring costs per source is equal to about $1,625 per source per month.

As shown in Table 4.2, in the simplest case where conveyance and engineering/design costs are ignored or assumed to be equivalent, it is currently cheaper to irrigate with potable water than with reclaimed Class D water for applications less than about 3 acre-feet per month. If more than 3 acre-feet per month are required, reclaimed Class D wastewater may prove to be a less costly alternative for the limited uses identified previously.

Table 4.2 Comparison of potable and reclaimed water costs[1]

Water Volume (acre-feet)	Monthly Cost of Potable Water ($)	Monthly Monitoring Costs for Reclaimed Class D Water ($)
1	618	1,625
2	1,228	1,625
3	1,838	1,625
4	2,448	1,625
5	3,058	1,625

[1] Assumes that no additional treatment is required to reliably achieve the Class D standard and that conveyance costs are equal.

5. SUMMARY AND CONCLUSIONS

In general, the costs to 1) monitor the reclaimed water quality, 2) provide additional treatment to the available wastewater, 3) convey the reclaimed water to places of reuse, and 4) the current costs of potable water limit the current water reclamation and reuse opportunities on the Reservation. At some time in the future, however, especially with new economic development activities, water reclamation and reuse may become cost effective.

Currently, only the wastewater from the two wastewater treatment plants is sampled and analyzed for the required parameters (except for turbidity and total coliform) at the designated sampling frequencies (except for total coliform and total suspended solids). As a result, before the opportunities for wastewater reclamation and reuse on the Reservation can be fully evaluated, wastewater quality monitoring for the five identified parameters at the specified sampling frequency must be conducted. This information will allow the wastewater quality and variations in the wastewater quality throughout a year to be quantified for each source and the appropriate treatment determined. This information would then be used to develop the required engineering/design report for a water reclamation and reuse system.

Available information suggests that the sampling equipment (~ $4,000) and the required sample analyses at a certified laboratory (~ $19,500) would cost around $25,000 per source during the first year of monitoring. Additional labor costs would be associated with obtaining, operating, and maintaining the sampling equipment. Thus, the total cost to adequately characterize the wastewater quality of a single potential source for one year would be about $30,000. Monitoring costs during subsequent years would be approximately $25,000.

The Lummi Nation's wastewater reuse opportunities for each potential source are summarized below and in Table 5.1.

Skookum Creek Fish Hatchery: Water is already serially reused in the raceways and rearing ponds of the Skookum Creek Fish Hatchery. This reuse network could be expanded by installing pipelines to allow the wastewater from the rearing ponds to supply the brood pond during the fall ($10,000). Although there are risks of disease transmission, the advantages of providing more cool, oxygen laden water to the rearing ponds during a low flow period in Skookum Creek may offset the risk.

In general however, concerns about disease transmission limit further water reuse opportunities at the Skookum Creek Fish Hatchery. In addition, the remote location and relatively high rainfall amounts received at the hatchery limit water reuse opportunities for other applications such as irrigation.

Seaponds Fish Hatchery: Water reclamation and reuse at the Seaponds Fish Hatchery is believed to be improbable due to the poor quality of the water supply source, the remote location of the facility, and the timing of wastewater availability. Wastewater is not available during the summer irrigation season from this source.

Mamoya Pond Fish Hatchery: Similar to the Seaponds Fish Hatchery, water reclamation and reuse at the Mamoya Pond Fish Hatchery is believed to be improbable due to the poor quality of the water supply source, the remote location of the facility, and the timing of wastewater availability. Wastewater is not available during the summer irrigation season from this source.

Sandy Point Fish Hatchery: Available data (one grab sample) suggests that wastewater from the Sandy Point Fish Hatchery may meet the Class D reclaimed water standard without further treatment. Based on the water quality standards for reuse, this wastewater may be suitable for flushing sanitary sewers, for irrigating nonfood crops (e.g., trees and fodder, fiber, and seed crops), for spray or surface irrigation of food crops which undergo physical or chemical processing sufficient to destroy all pathogenic organisms, and for surface irrigation of orchards and vineyards. However, considerably more sampling and analysis is required to determine if the Class D standard is reliably attained and to comply with monitoring requirements. An engineering report would also be required.

The cost of treatment and monitoring necessary to recirculate the water in the hatchery (Class B) was estimated to be approximately $45,000 during the first year and about $20,000 for subsequent years. Treatment to the Class A standard is required if the wastewater is to be reused in open access areas such as golf courses, parks, playgrounds, school yards, and residential landscapes. To treat and monitor wastewater from the Sandy Point Fish Hatchery to the Class A standard would cost approximately $80,000 during the first year and about $20,000 in subsequent years.

If the wastewater from the Sandy Point Fish Hatchery were to be reused for irrigation in the Lummi River flood plain, relocating the hatchery to a parcel closer to the well site should be evaluated. If the hatchery could be moved to the higher elevation, the wastewater conveyance costs would be reduced due to both the shorter distance to the flood plain and the reduced need to pump the reclaimed water.

Gooseberry Point Wastewater Treatment Plant: Until the effluent from the Gooseberry Point Wastewater Treatment Plant reliably meets the water quality standards for Class D reclaimed water through additional or more effective treatment, the effluent should not be reused. Additional treatment will be required before water can be reclaimed for most uses. In addition, the turbidity and total coliform levels of the effluent would need to be monitored and the coliform and total suspended solid levels monitored more frequently. The wastewater quality and remote location of the treatment plant currently limits opportunities to reuse the wastewater.

Sandy Point Wastewater Treatment Plant: Similar to the Gooseberry Point Wastewater Treatment Plant, until the effluent from the Sandy Point Wastewater Treatment Plant reliably meets the water quality standards for Class D reclaimed water through additional or more effective treatment, the effluent should not be reused. Additional treatment will be required before water can be reclaimed for most uses. In addition, the turbidity and total coliform levels of the effluent would need to be monitored and the coliform and total suspended solid levels monitored more frequently. The wastewater quality and remote location of the treatment plant currently limits opportunities to reuse the wastewater.

LIBC Seafood Processing Plant: Unless a nearby land use is developed with plans for a conjunctive water use, or the Gooseberry WWTP is upgraded, the small wastewater volumes, distant location from irrigated land, and the costs of treatment and monitoring requirements limit the feasibility of reclaiming and reusing wastewater from the LIBC seafood processing plant.

Finkbonner Shellfish Processing Plant: Similar to the LIBC seafood processing plant, unless a nearby land use is developed with plans for a conjunctive water use, or the Gooseberry WWTP is upgraded, the small wastewater volumes, distant location from irrigated land, and the costs of treatment and monitoring requirements limit the feasibility of reclaiming and reusing wastewater from the Finkbonner Shellfish processing plant.

Table 5.1 Summary of Lummi wastewater reclamation and reuse opportunities

Potential Source	Wastewater Quantity	Wastewater Quality	Monitoring Costs	Estimated Treatment Costs			
				Class A	Class B	Class C	Class D
1. Gooseberry Point Wastewater Treatment Plant	• Average flow during month of maximum wastewater flow (August) is approximately 0.29mgd • Average flow during month of minimum wastewater flow (July) is approximately 0.16 mgd • Average annual wastewater volume is approximately 263.8 ac-ft	• Improved operations required to meet Class D standards. • Additional treatment required to meet Class A, B, and C standards. • Increased monitoring required (more parameters and more frequent sampling)	Year 1: $30,000 Subsequent Years: $25,000	$1,000,000	$750,000	$300,000	$0
2. Sandy Point Wastewater Treatment Plant	• Average flow during month of maximum wastewater flow (July) is approximately 0.20 mgd • Average flow during month of minimum wastewater flow (March) is approximately 0.10mgd • Average annual wastewater volume is approximately 166.8 ac-ft	• Improved operations required to meet Class D standards. • Additional treatment required to meet Class A, B, and C standards. • Increased monitoring required (more parameters and more frequent sampling)	Year 1: $30,000 Subsequent Years: $25,000	$1,000,000	$750,000	$300,000	$0
3. Sandy Point Fish Hatchery	• Average flow during month of maximum wastewater flow (December) is approximately 0.12 mgd • Average flow during month of minimum wastewater flow (June) is	• Additional treatment likely required to meet Class A, B, and C standards. • Might meet Class D standard without further treatment • Increased monitoring	Year 1: $30,000 Subsequent Years: $25,000	$55,000	$18,000	$18,000	$0

Table 5.1 Summary of Lummi wastewater reclamation and reuse opportunities

Potential Source	Wastewater Quantity	Wastewater Quality	Monitoring Costs	Estimated Treatment Costs Class A	Class B	Class C	Class D
	approximately 0.05 mgd • Average annual wastewater volume is approximately 89.9 ac-ft	required (more parameters and more frequent sampling)					
4. Skookum Creek Fish Hatchery	• Average flow during month of maximum wastewater flow (May) is approximately 7.8 mgd • Average flow during month of minimum wastewater flow (June) is approximately 0.51 mgd • Average annual wastewater volume is approximately 4,701.9 ac-ft	• Additional treatment likely required to meet Class A, B, and C standards. • Might meet Class D standard without further treatment • Increased monitoring required (more parameters and more frequent sampling)	Year 1: $30,000 Subsequent Years: $25,000	ND[1]	ND	ND	ND
5. Seaponds Fish Hatchery	• Average flow during month of maximum wastewater flow (May) is approximately 0.74 mgd • Average flow during month of minimum wastewater flow (June through August) is approximately 0 mgd • Average annual wastewater volume is approximately 93.4 ac-ft	• Additional treatment likely required to meet Class A, B, C, and D standards. • Increased monitoring required (more parameters and more frequent sampling)	Year 1: $30,000 Subsequent Years: $25,000	ND	ND	ND	ND
6. Mamoya Ponds Fish Hatchery	• Average flow during month of maximum wastewater flow (May) is approximately 3.1 mgd • Average flow during	• Additional treatment likely required to meet Class A, B, C, and D standards. • Increased monitoring	Year 1: $30,000 Subsequent Years:	ND	ND	ND	ND

Table 5.1 Summary of Lummi wastewater reclamation and reuse opportunities

Potential Source	Wastewater Quantity	Wastewater Quality	Monitoring Costs	Estimated Treatment Costs Class A	Class B	Class C	Class D
	month of minimum wastewater flow (June through August) is approximately 0 mgd • Average annual wastewater volume is approximately 389.0 ac-ft	required (more parameters and more frequent sampling)	$25,000				
7. LIBC Seafood Processing Plant	• Average flow during month of maximum wastewater flow (August through November) is approximately 0.03 mgd • Average flow during month of minimum wastewater flow (December through July) is approximately 0 mgd • Average annual wastewater volume is approximately 11.2 ac-ft	• Additional treatment required to meet Class A, B, C and D standards. • Increased monitoring required (more parameters and more frequent sampling)	Year 1: $30,000 Subsequent Years: $25,000	ND	ND	ND	ND
8. Finkbonner Shellfish Company	• Average flow throughout year estimated to be approximately 0.0001 mgd • Average annual wastewater volume is approximately 0.1 ac-ft	• Additional treatment required to meet Class A, B, C and D standards. • Increased monitoring required (more parameters and more frequent sampling)	Year 1: $30,000 Subsequent Years: $25,000	ND	ND	ND	ND

[1] ND = Not determined. Treatment costs for these sources were not determined because the sources are not considered to be a viable sources for water reclamation and reuse due to poor water quality, location, and/or unavailable wastewater during the summer irrigation season.

6. REFERENCES

Bertolini, Jim Ph.D. 1997. Fish Pathologist, Northwest Indian Fisheries Commission. Personal communication - Letter to Jeremy Freimund, Lummi Nation. March 11,1997

Decoteau, Eugene. 1997. Lummi Sewer District Manager. Personal communication - FAX to Jeremy Freimund, Lummi Nation. July 31, 1997.

Delgado, Linda. 1998. Manager, Lummi Salmon Enhancement Program. Personal communication - Cost Proposals to Lummi Indian Business Council. January 5, 1998.

Dunphy, Gregg. 1997. Environmental Protection Coordinator. Personal communication - Memorandum to Harriet Beale, Lummi Water Resources Manager. June 9, 1997

Ernst, Joann. 1997. Operations Manager, Avocet Environmental Testing. Personal communication - Letter to Jeremy Freimund, Lummi Nation. May 5, 1997.

Esvelt, Richard. 1997. Principle, H.R. Esvelt Engineering. Personal communication - Letter to Jeremy Freimund, Lummi Nation. February 4, 1997.

HDR Engineering, Inc. (HDR). 1996. Letter Report: Survey of Other States' Standards for the Use of Reclaimed Water for Ground Water Recharge by Injection. Dec. 4, 1996.

Leffel, John. 1997. Tribal Utility Consultant, Indian Health Service. Personal communication - Letter to Eugene Decoteau, Lummi Sewer District Manager. January 14, 1997.

Pringle, George. 1997. Tribal Utility Consultant, Indian Health Service. Personal communication - Letter to Jeremy Freimund, Lummi Nation. September 15, 1997.

U.S. Environmental Protection Agency (EPA). 1975. Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Fish Meal, Salmon, Bottom Fish, Clam, Oyster, Sardine, Scallop, Herring, and Abalone Segment of the Canned and Preserved Fish and Seafood Processing Industry Point Source Category. EPA Effluent Guidelines Division, September 1975.

U.S. Environmental Protection Agency (EPA). 1992. Guidelines for Water Reuse. Technology Transfer Manual. GPO, Washington, D.C. EPA/625/R-92/004. 247 p.

Washington State Department of Health (DOH). 1996a. Overview of Washington State Reclaimed Water Standards. June 1996.

Washington State Department of Health and the Department of Ecology (DOH and DOE). 1997. Water Reclamation and Reuse Standards. September 1997, Pub. #97-23.